II. CLAIM AMENDMENTS

1. (Previously Presented) A method for implementing an approximation of a discrete cosine transform (DCT) and for implementing a quantization operation, the discrete cosine transform and quantization operation to be applied in sequence to digital data for compression of said digital data, the method comprising:

simplifying a predetermined transform matrix to require less operations when applied to digital data, thereby forming a simplified transform matrix;

approximating elements of said simplified transform matrix constituting irrational numbers by rational numbers;

extending a predetermined quantization operation to include operations removed by simplifying the predetermined transform matrix, thereby forming an extended quantization operation;

adjusting the extended quantization operation to compensate for approximation of elements of said simplified transform matrix by rational numbers; and

employing said simplified transform matrix with said approximated elements and said extended quantization operation as basis for implementing said sequence of discrete cosine transform and quantization operation.

2. (Original) A method according to claim 1, wherein said step of simplifying said predetermined transform matrix to require less operations when applied to digital data comprises factoring said predetermined transform matrix into a diagonal matrix to be used for extending said predetermined quantization and a simplified transform matrix.

3. (Original) A method according to claim 1, wherein said rational numbers can be represented by fractions having a denominator equal to 2^n, wherein n is an integer.

4. (Original) A method according to claim 3, wherein in said transform implementation divisions are realized by bit-shifting.

5. (Original) A method according to claim 1, wherein said approximation is adjusted in a way ensuring that a resulting transform has an inverse transform, i.e. that a transpose of said predetermined transform matrix, including said approximations, multiplied by said predetermined transform matrix, including said approximations, is equal to an identity matrix.

6. (Currently Amended) A method according to claim 1, wherein said predetermined transform matrix is a 4x4 matrix of a form:

$$\begin{bmatrix} a & a & a & a \\ b & c & -c & -b \\ a & -a & -a & a \\ c & -b & b & -c \end{bmatrix},$$

wherein $a = 1/2, b = \sqrt{1/2} \cdot \cos(\pi/8), c = \sqrt{1/2} \cdot \cos(3\pi/8)$, wherein 'c' is

substituted in said matrix according to an equation d=c/b, and wherein said predetermined transform matrix is simplified by factoring said predetermined transform matrix into a diagonal matrix comprising diagonal values {a, b, a, b} and a simplified transform matrix comprising only elements having absolute values of '1' and 'd', which diagonal matrix is to be used for extending said predetermined quantization operation.

7. (Original) A method according to claim 6, wherein in said simplified transform matrix said value 'd' is approximated by a rational number 7/16.

8. (Original) A method according to claim 6, wherein in said simplified transform matrix said value 'd' is approximated by a rational number, and wherein in said diagonal matrix said value 'b' is adjusted to $b=\sqrt{\frac{0.5}{1+d^2}}$, 'd' being in said equation said rational number.

9. (Original) A method according to claim 6, wherein in said simplified transform matrix said value 'd' is approximated by a rational number 7/16, and wherein said transform is implemented for a transform of a one-dimensional sequence of four values X[0],X[1],X[2],X[3] respectively with the following equations:

e = X[0] + X[3],

f = X[1] + X[2],

Y[0] = e + f,

Y[2] = e - f,

e = X[0] - X[3],

f = X[1] - X[2],

Y[1] = e + (f - f/8)/2, and

Y[3] = (e - e/8)/2 - f,

wherein Y[0],Y[1],Y[2],Y[3] is a one-dimensional sequence of four transformed values, and wherein e and f are auxiliary variables.

10. (Currently Amended) A method according to claim 1, wherein said predetermined transform matrix is a 8x8 matrix of a form:

$$\begin{bmatrix} a & a & a & a & a & a & a & a \\ b & c & d & e & -e & -d & -c & -b \\ f & g & -g & -f & -f & -g & g & f \\ c & -e & -b & -d & d & b & e & -c \\ a & -a & -a & a & a & -a & -a & a \\ d & -b & e & c & -c & -e & b & -d \\ g & -f & f & -g & -g & f & -f & g \\ e & -d & c & -b & b & -c & d & -e \end{bmatrix}$$

wherein $a = 1/(2\sqrt{2}), b = 1/2 \cdot \cos(\pi/16), c = 1/2 \cdot \cos(3\pi/16),$

$d = 1/2 \cdot \cos(5\pi/16), e = 1/2 \cdot \cos(7\pi/16), f = 1/2 \cdot \cos(\pi/8),$

$g = 1/2 \cdot \cos(3\pi/8)$, wherein 'c' is substituted in said matrix according to an equation c_b=c/b, wherein 'd' is substituted in said matrix according to an equation d_b=d/b, wherein 'e' is substituted in said matrix according to an equation e_b=e/b, wherein 'g' is substituted in said matrix according to an equation g_f=g/f, and wherein said predetermined transform matrix is simplified by factoring said predetermined transform matrix into a diagonal matrix

comprising diagonal values {a, b, f, b, a, b, f, b} and a simplified transform matrix comprising only elements having absolute values of '1', 'c_b', 'd_b', 'e_b' and 'g_f', which diagonal matrix is to be used for extending said predetermined quantization operation.

11. (Original) A method according to claim 10, wherein in said simplified transform matrix said value 'c_b' is approximated by a rational number 15/16, said value 'd_b' is approximated by a rational number 9/16, said value 'e_b' is approximated by a rational number 1/4, and said value 'g_f' is approximated by a rational number 7/16.

12. (Original) A method according to claim 10, wherein in said simplified transform matrix said values 'c_b', 'd_b', 'e_b' and 'g_f' are approximated by rational numbers, and wherein in said diagonal matrix said values 'b' and 'f' are adjusted to $b = \frac{1}{\sqrt{2}} \frac{1}{\sqrt{1 + c_b^2 + d_b^2 + e_b^2}}$ and $f = \frac{1}{2} \frac{1}{\sqrt{1 + g_f^2}}$, values '$c_b$', '$d_b$', '$e_b$' and '$g_f$' being in said equation said rational numbers.

13. (Original) A method according to claim 1, wherein for a two-dimensional transform to be applied to two-dimensional digital data, said simplified predetermined transform matrix with said approximated elements and a transpose of said simplified transform matrix with said approximated elements are employed as basis for implementing said transform, said extended quantization including operations removed from both of said matrices, which

operations are adjusted to compensate for said approximations in both of said matrices.

14. (Original) A method according to claim 1, wherein for quantization, a quantization matrix is determined by multiplying a predetermined sequence of quantization coefficients with a matrix extracted from said predetermined transform matrix for simplifying said predetermined transform matrix, which extracted matrix comprises said operations removed from said predetermined transform matrix, and which extracted matrix is adjusted to compensate for said approximation of elements of said simplified transform matrix by rational numbers.

15. (Previously Presented) A method for implementing a dequantization operation and for implementing an approximation of an inverse discrete cosine transform (IDCT), the dequantization operation and inverse discrete cosine transform to be applied in sequence for decompression of compressed digital data, the method comprising:

simplifying a predetermined inverse transform matrix to require less operations when applied to digital data, thereby forming a simplified inverse transform matrix;

approximating elements of said simplified inverse transform matrix constituting irrational numbers by rational numbers;

extending a predetermined dequantization operation to include operations removed by simplifying the predetermined inverse

transform matrix, thereby forming an extended dequantization operation;

adjusting the extended dequantization operation to compensate for approximation of elements of said simplified inverse transform matrix by rational numbers; and

employing said extended dequantization operation and said simplified inverse transform matrix with said approximated elements as basis for implementing said sequence of dequantization operation and inverse discrete cosine transform.

16. (Original) A method according to claim 15, wherein for dequantization, a dequantization matrix is determined by multiplying a predetermined sequence of dequantization coefficients with a matrix extracted from said predetermined inverse transform matrix for simplifying said predetermined inverse transform matrix, which extracted matrix comprises said operations removed from said predetermined inverse transform matrix, and which extracted matrix is adjusted to compensate for said approximation of elements of said simplified inverse transform matrix by rational numbers.

17. (Original) A method according to claim 15, wherein said step of simplifying said predetermined inverse transform matrix to require less operations when applied to digital data comprises factoring said predetermined inverse transform matrix into a diagonal matrix to be used for extending said predetermined dequantization and a simplified inverse transform matrix.

18. (Original) A method according to claim 15, wherein said rational numbers can be represented by fractions having a denominator equal to 2^n, wherein n is an integer.

19. (Original) A method according to claim 18, wherein in said inverse transform implementation divisions are realized by bit-shifting.

20. (Original) A method according to claim 15, wherein said approximation is adjusted in a way ensuring that a resulting inverse transform corresponds to a transform, i.e. that said predetermined inverse transform matrix, including said approximations, multiplied by a transpose of said predetermined inverse transform matrix, including said approximations, is equal to an identity matrix.

21. (Original) A method according to claim 15, wherein said predetermined inverse transform matrix is a 4x4 matrix of a form

$$\begin{bmatrix} a & b & a & c \\ a & c & -a & -b \\ a & -c & -a & b \\ a & -b & a & -c \end{bmatrix},$$

wherein $a = 1/2, b = \sqrt{1/2} \cdot \cos(\pi/8), c = \sqrt{1/2} \cdot \cos(3\pi/8)$, wherein 'c' is substituted in said matrix according to an equation d=c/b, and wherein said predetermined inverse transform matrix is simplified by factoring said predetermined inverse transform matrix into a diagonal matrix comprising diagonal values {a, b, a, b} and a simplified inverse transform matrix comprising only elements

having absolute values of '1' and 'd', which diagonal matrix is to be used for extending said predetermined dequantization.

22. (Original) A method according to claim 21, wherein in said simplified inverse transform matrix said value 'd' is approximated by a rational number 7/16.

23. (Original) A method according to claim 21, wherein in said simplified inverse transform matrix said value 'd' is approximated by a rational number, and wherein in said diagonal matrix said value 'b' is adjusted to $b=\sqrt{\frac{0.5}{1+d^2}}$, 'd' being in said equation said rational number.

24. (Original) A method according to claim 21, wherein in said simplified inverse transform matrix said value 'd' is approximated by a rational number 7/16, and wherein said inverse is implemented for a transform of a one-dimensional sequence of four values X[0],X[1],X[2],X[3] respectively with the following equations:

e = X[0] + X[3],

f = X[1] + X[2],

Y[0] = e + f,

Y[2] = e - f,

e = X[0] - X[3],

f = X[1] - X[2],

Y[1] = e + (f - f/8)/2, and

Y[3] = (e - e/8)/2 - f,

wherein Y[0],Y[1],Y[2],Y[3] is a one-dimensional sequence of four transformed values, and wherein e and f are auxiliary variables.

25. (Currently Amended) A method according to claim 15, wherein said predetermined inverse transform matrix is a 8x8 matrix of a form:

$$\begin{bmatrix} a & b & f & c & a & d & g & e \\ a & c & g & -e & -a & -b & -f & -d \\ a & d & -g & -b & -a & e & f & c \\ a & e & -f & -d & a & c & -g & -b \\ a & -e & -f & d & a & -c & -g & b \\ a & -d & -g & b & -a & -e & f & -c \\ a & -c & g & e & -a & b & -f & d \\ a & -b & f & -c & a & -d & g & -e \end{bmatrix}$$

wherein $a = 1/(2\sqrt{2}), b = 1/2 \cdot \cos(\pi/16), c = 1/2 \cdot \cos(3\pi/16)$, $d = 1/2 \cdot \cos(5\pi/16), e = 1/2 \cdot \cos(7\pi/16), f = 1/2 \cdot \cos(\pi/8)$, $g = 1/2 \cdot \cos(3\pi/8)$, wherein 'c' is substituted in said matrix according to an equation $c_b=c/b$, wherein 'd' is substituted in said matrix according to an equation $d_b=d/b$, wherein 'e' is substituted in said matrix according to an equation $e_b=e/b$, wherein 'g' is substituted in said matrix according to an equation $g_f=g/f$, and wherein said predetermined inverse transform matrix is simplified by factoring said predetermined <u>inverse </u>transform matrix into a diagonal matrix comprising diagonal values {a, b, f, b, a, b, f, b} and a simplified inverse transform matrix comprising only elements having absolute values of '1', 'c_b', 'd_b', 'e_b' and 'g_f', which

diagonal matrix is to be used for extending said predetermined dequantization.

26. (Previously Presented) A method according to claim 25, wherein in said simplified inverse transform matrix said value 'c_b' is approximated by a rational number 15/16, said value 'd_b' is approximated by a rational number 9/16, said value 'e_b' is approximated by a rational number 1/4, and said value 'g_f' is approximated by a rational number 7/16.

27. (Previously Presented) A method according to claim 25, wherein in said simplified inverse transform matrix said values 'c_b', 'd_b', 'e_b' and 'g_f' are approximated by rational numbers, and wherein in said diagonal matrix said values 'b' and 'f' are adjusted to $b=\frac{1}{\sqrt{2}}\frac{1}{\sqrt{1+c_b^2+d_b^2+e_b^2}}$ and $f=\frac{1}{2}\frac{1}{\sqrt{1+g_f^2}}$, values '$c_b$', '$d_b$', '$e_b$' and '$g_f$' being in said equation said rational numbers.

28. (Currently Amended) A method according to claim 15, wherein for a two-dimensional inverse transform to be applied to two-dimensional dequantized digital data, said simplified predetermined inverse transform matrix with said approximated elements and a transpose of said simplified inverse transform matrix with said approximated elements are employed as basis for implementing said inverse transform, said extended dequantization operation including operations removed from both of said matrices, which operations are adjusted to compensate for said approximations in both of said matrices.

29. (Previously Presented) An encoder for compressing digital data comprising:

a transformer arranged to approximate a discrete cosine transform (DCT) for transforming digital data by applying a simplified transform matrix to said digital data, the simplified transform matrix being obtained by simplifying a predetermined transform matrix to require less operations when applied to digital data, and in which simplified transform matrix elements constituting irrational numbers are approximated by rational numbers; and

a quantization means coupled to an output of said transformer, arranged to quantize transformed digital data by performing an extended quantization operation, the extended quantization operation being obtained from a predetermined quantization operation by including operations removed by simplifying the predetermined transform matrix, said extended quantization operation being adjusted to compensate for said approximation of elements of said simplified transform matrix.

30. (Previously Presented) A decoder for decompressing digital data comprising:

a dequantization means arranged to dequantize compressed digital data with an extended dequantization operation; and

a transformer arranged to approximate an inverse discrete cosine transform (IDCT) coupled to an output of said dequantization means for transforming dequantized digital

data by applying a simplified inverse transform matrix, the simplified inverse transform matrix being obtained by simplifying a predetermined inverse transform matrix to require less operations when applied to digital data, and in which simplified inverse transform matrix elements constituting irrational numbers are approximated by rational numbers;

wherein the extended dequantization operation applied by said dequantization means is obtained from a predetermined dequantization operation by including operations removed by simplifying the predetermined inverse transform matrix, said extended dequantization operation being adjusted to compensate for said approximation of elements of said simplified inverse transform matrix.

31. (Previously Presented) A method of encoding digital data, the method comprising:

transforming said digital data by applying a simplified transform matrix to said digital data, the simplified transform matrix being obtained by simplifying a predetermined transform matrix to require less operations when applied to digital data, and in which simplified transform matrix elements constituting irrational numbers are approximated by rational numbers; and

quantizing said transformed digital data by performing an extended quantization operation, the extended quantization operation being obtained from a predetermined quantization operation by including operations removed by simplifying the

predetermined transform matrix, said extended quantization operation being adjusted to compensate for said approximation of elements of said simplified transform matrix.

32. (Previously Presented) A method of decoding compressed digital data, the method comprising:

dequantizing said compressed digital data with an extended dequantization operation; and

transforming said dequantized digital data by applying a simplified inverse transform matrix, the simplified inverse transform matrix being obtained by simplifying a predetermined inverse transform matrix to require less operations when applied to digital data, and in which simplified inverse transform matrix elements constituting irrational numbers are approximated by rational numbers;

wherein the extended dequantization operation is obtained from a predetermined dequantization operation by including operations removed by simplifying the predetermined inverse transform matrix, said extended dequantization operation being adjusted to compensate for said approximation of elements of said simplified inverse transform matrix.